

# Size change of eggs during the incubation period in three Asian honey bee species

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## Introduction

Very few investigations have been conducted on the size of honey bee eggs. Hejtmanek (1961) measured the size of about 7000 eggs. He found both seasonal and colony variation. In general, eggs were smaller as more were produced. These findings were confirmed by Jordan (1961). According to Borodacheva (1973), queens reared from heavier eggs were heavier and had more ovarioles than those from lighter ones. The weight of eggs also affected the external characters of workers to some extent. Bilash *et al.* (1985) showed that colonies headed by queens reared from heavier eggs produced more honey than those headed by queens hatched from lighter eggs.

Size of eggs of three species of Asian honey bees was measured by Woyke (1975).

It is believed that an egg does not change its size after it is deposited into the comb cell. In the present studies, size changes of eggs during the incubation period were investigated.

## Materials and Methods

An *Apis cerana indica* queen was confined for either 4 or 6 hours on a comb under a queen-excluder cap. The queen was then moved to another comb. At regular periods eggs were removed and their width and length were measured under a stereomicroscope. The width was measured in the middle of egg length. Drawings and measurements of the length of embryos inside the eggs were made.

Eggs of *A. florea* and *A. dorsata* were removed from combs. Age of those eggs was determined by the size and development stage of the embryo inside the egg. Analysis of variance was applied to the results. The Newman-Keuls test was used to determine significant differences between the means.

Table 1. Size of *Apis cerana* eggs

Age of eggs in hours	No	Width		Length		Embryo Length	
		mm	%	mm	%	mm	% Emb/Egg
<u>Series 1 July 25</u>							
0-4	5	0.406a*	100.0	1.710ab	100.0	-	-
6-10	5	0.400ab	98.5	1.745a	102.0	1.670a	95.7
24-28	5	0.389b	95.8	1.730a	101.2	1.528b	88.3
48-52	5	0.370c	91.1	1.670b	97.7	1.380d	82.6
54-58	5	0.361c	88.9	1.705ab	99.7	1.465c	85.9
68-72	5	0.355c	87.4	1.665b	97.4	1.510b	90.1
<u>Series 2 August 7</u>							
2-18	3	0.406a		1.767a		-	-
24-30	3	0.391b		1.758a		-	-
36-42	3	0.374c		1.750a		1.550a	88.6
48-54	5	0.373d		1.685b		1.490a	88.4
60-66	5	0.359e		1.745a		1.590a	91.1
66-72	3	0.358f		1.721ab		1.583a	92.0
<u>Series 3 August 23</u>							
36-42	8	0.355a		1.745a		1.597a	91.5
48-54	5	0.347a		1.735a		1.425b	82.1
60-66	10	0.324b		1.740a		1.581a	90.1

\* Different letters indicate significant differences between means ( $P < 0.05$ )

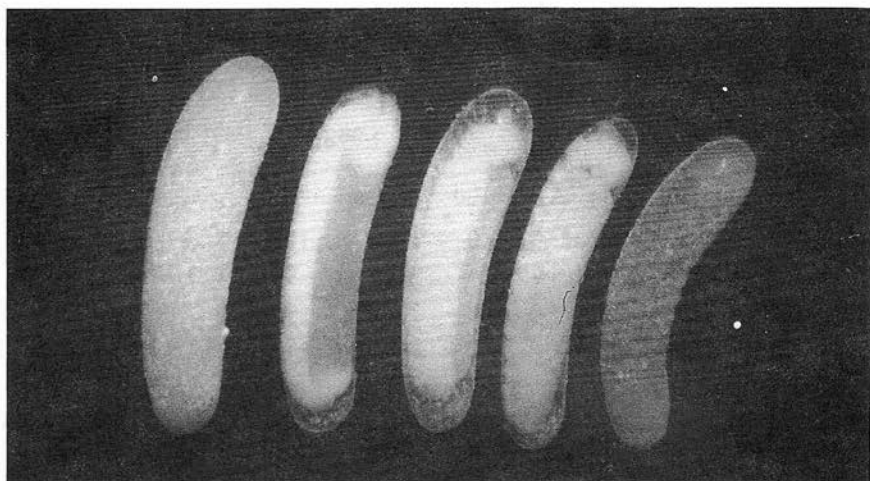


Figure 1. *Apis cerana* eggs of different ages.

## Results

The results presented in Table 1, series 1, show that eggs of *A. cerana* 0-4 hrs old were 0.406 mm wide. Size changes were noticed 6 hrs after the first measurements. At this time, the width decreased to 98.5% of that of the newly laid eggs. Eggs 24-28 hrs old were significantly thinner than the newly laid ones. The width of eggs 48 hrs old was significantly smaller than that of both 24-28 and 0-4 hrs old eggs. Eggs just before hatching decreased their width to 87.7% of that of the newly laid ones. Thus the eggs decreased their width during the whole incubation period.

Eggs 0-4 hrs old were 1.710 mm long. After 6 hrs, the length increased to 102%. But later, the length decreased to 97.7% in eggs 48-58 hrs old. Those eggs were significantly shorter than eggs one day younger. The length of older eggs (54-58 hrs) increased to 99.7%, and then dropped again to 97.3% in eggs just before hatching. Figure 2 shows that the variation as well as the median values of the length of eggs present the same regularity. The length of eggs increased at first, then it decreased, till the age of 48-58 hrs. Next it increased, and then decreased again just before hatching.

Table 1, series 2, does not contain data concerning the youngest eggs. Nevertheless, two weeks later, older eggs were also significantly thinner than younger ones. The length of eggs decreased till the age of 48-54 hrs, when the eggs were the shortest. Eggs at this stage were significantly shorter than both the younger

Table 2. Size of *Apis florea* eggs

Age in hours	No	Width		Length		Embryo Length	
		mm	%	mm	%	mm %	Emb/Egg
0-10	5	0.415a*	100.0	1.675a	100.0	-	-
48-52	6	0.395b	95.1	1.658a	99.0	1.288c	77.7
54-58	5	0.380c	91.6	1.668a	99.6	1.360b	81.5
66-72	5	0.373c	89.9	1.656a	98.9	1.445a	87.3

\* Different letters indicate significant differences between means ( $P < 0.05$ )

as well as the older ones. Measurements conducted two weeks later (Table 1, series 3) showed the same tendency. The width of eggs decreased during the incubation period. No statistically significant differences were found in the length of eggs of

Age hs	Minimum	25th %tile	Median	75th %tile	Maximum
0-4	1.67	1.69	1.73	1.73	1.73
6-10	1.70	1.73	1.75	1.76	1.77
24-28	1.70	1.71	1.73	1.75	1.75
48-52	1.63	1.65	1.67	1.69	1.70
54-58	1.67	1.67	1.70	1.74	1.75
67-71	1.63	1.64	1.67	1.69	1.70

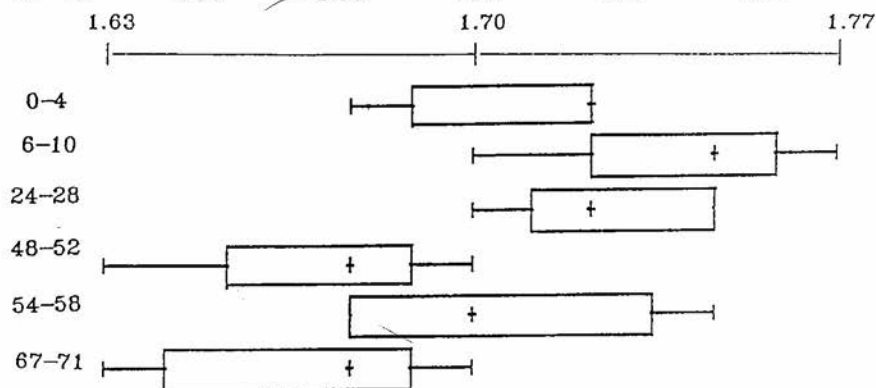
Figure 2. Variation in the length (mm) of *Apis cerana* eggs of different ages.

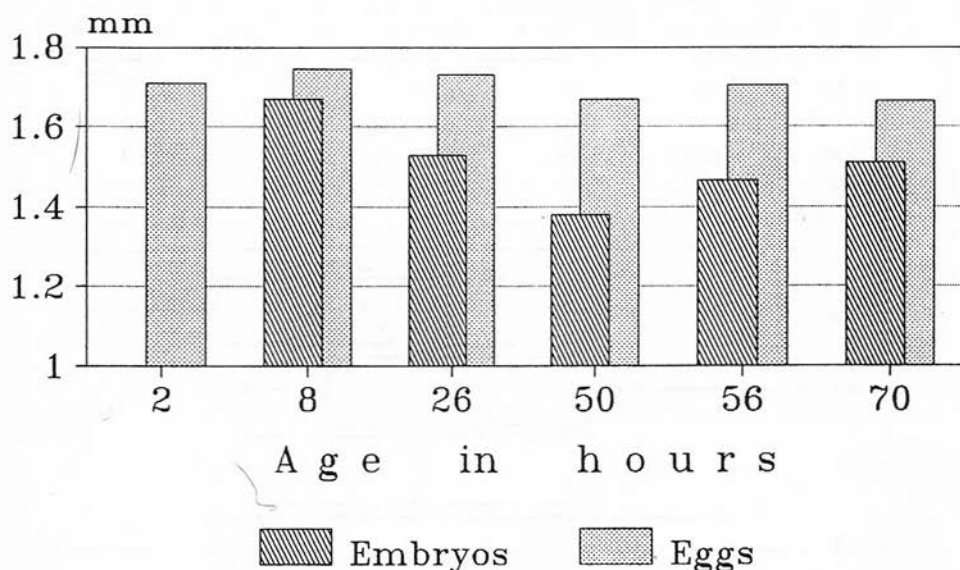
Table 3. Size of *Apis dorsata* eggs

Age in hours	No	Width		Length	
		mm	%	mm	%
0-10	8	0.413a*	100.0	1.984a	100.0
48-54	5	0.400b	96.9	1.925b	96.8
66-72	5	0.369c	89.3	1.870c	94.3

\* Different letters indicate significant differences between means ( $P < 0.05$ )

different age. However, the absolute value of the length of eggs 48-54 hrs old was lower than both the younger as well as the older ones. Thus the same tendency was noticed here as found in both earlier series.

In all three series the absolute values of the length of eggs 48-54 hrs old were lower than that of both younger or older eggs. This was confirmed statistically in

Figure 3. Length of *Apis cerana* embryos and eggs of different ages.

series 2. I conclude that the length of eggs decreases until they are 48-54 hrs old, then the length increases and then decreases again at the time of hatching.

Table 1 shows that the embryo also changed its size. In all three series, the length of the embryo shortened until 48-52-54 hrs old. Afterwards, the length increased until the time of hatching. In series 1 and 3, embryos 48-52-54 hrs old were significantly shorter than both the younger as well as the older ones. Figure 3 suggests that some correlation must exist between the length of the embryo and the egg. However, it must be noticed that starting from the age of 48-54 hrs, the embryo grew until the time of hatching, while the egg reduced its length before hatching. Table 1 shows that the ratio between the length of the embryo and that of the egg is not constant. At the age of 48-52-54 hrs the embryo occupied only 82-88% of the length of the egg. Younger and older embryos occupied 90-95% of the egg length. Correlation coefficients between the length of embryos and that of eggs for the three series were  $r = 0.686$ ,  $r = 0.745$  and  $r = 0.310$ .

Table 1 shows that eggs laid during the first two periods (July 25 and August

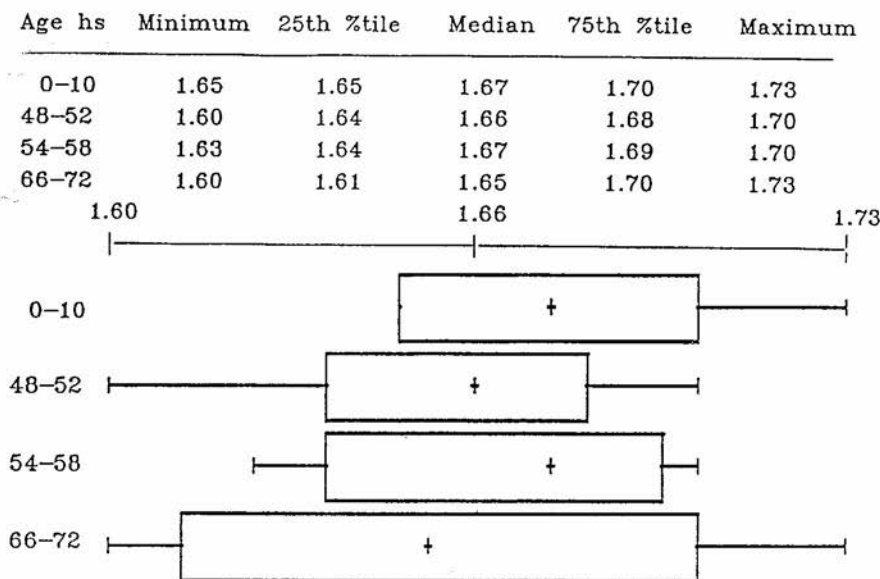


Figure 4. Variation in the length (mm) of *Apis florea* eggs of different ages.

7) were of similar size. However, statistical calculations showed that all eggs of series 3 (August 23) were significantly thinner than eggs of the corresponding age in both earlier series. Eggs 48-54 hrs old of series 3 were significantly longer than corresponding eggs in the two other series. Thus one can conclude that the size of eggs laid in various periods differs significantly.

*A. florea* eggs 0-10 hrs old were 0.415 mm wide (Table 2). The width decreased constantly till the time just before hatching. Differences between various aged eggs were significant. At hatching the width was 89.9% of that of the newly laid eggs. Eggs 0-10 hrs old were 1.675 mm long. No statistically significant differences were found between means of eggs of different age. However, absolute values of the means show the clear tendency that eggs 48-54 hrs old are the shortest, next their length increases, and then decreases at the time of hatching. This tendency is shown also by the variations and median values presented in Figure 4. At the time of hatching, the length of eggs was 98.9% of that of the newly laid ones. The length of embryos was the shortest in eggs 48-54 hrs old (Table 2). Later, the length increased constantly till the time of hatching. Differences between all means were significant. At the age of 48-52 hrs, the embryo occupied only 77.7% of the length of the egg. At the hatching time, the embryo occupied 87.3% of the egg length.

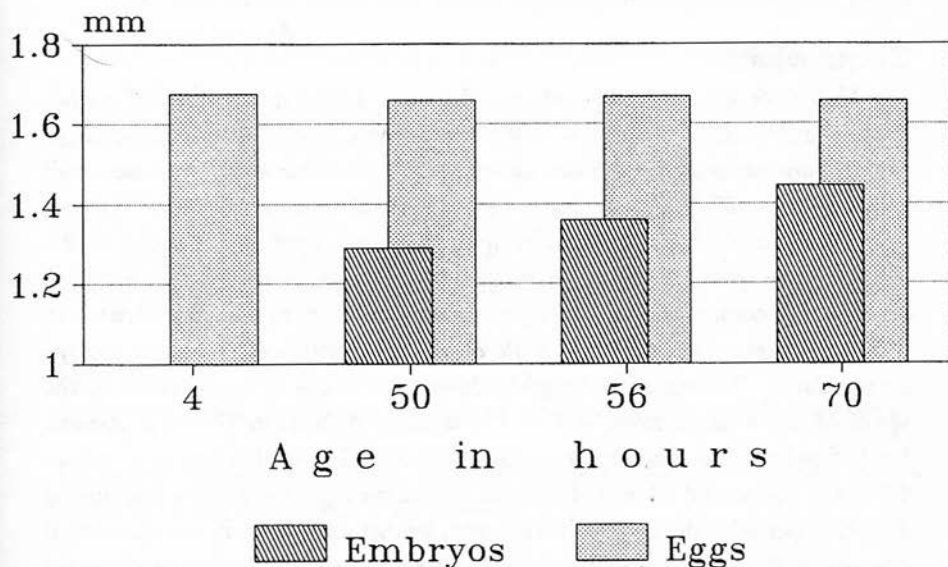


Figure 5. Length of *Apis florea* embryos and eggs of different ages.

Comparison of Figures 3 and 5 and Tables 1 and 2 shows that the embryo of *A. florea* occupied a smaller part of the egg than *A. cerana* embryo did.

*A. dorsata* eggs, 0 - 10 hrs old, were 0.413 mm wide (Table 3). Older eggs were thinner. Differences between all means were significant. At hatching the width of eggs was 89.3% of that of the newly laid ones. Eggs 0-10 hrs old were 1.984 mm long. Older eggs were shorter. Differences between all means were significant. The length of eggs at the time just before hatching was 94.3% of that of the newly laid ones. Drawings were made of the embryo in the egg without measuring its length. The embryo was the shortest in eggs 48-54 hrs old. Later its length increased till the time of hatching.

## Discussion

The size of eggs of three Asian honey bee species was measured by Woyke (1975). The results presented here agree with the photographic presentation of Milne *et al.* (1988). In that study, the embryo of *A. mellifera* changed its size during the development period. There exists seasonal variation in the size of *A. cerana* eggs as reported for *A. mellifera* by Hejtmanek (1961) and Jordan (1961). Although thousands of measurements of egg size have been made, there have been no previous reports that the egg changes its size during the incubation period.

## Conclusions

This work shows that eggs change their size during the incubation period. While the proportion of decrease in width and length is not the same, the changes are very similar in all three Asian honey bee species. The width decreases until hatching, up to 87.7% in *A. cerana*, 89.3% in *A. dorsata* and 89.9% in *A. florea*. There is a decrease in the length during the incubation period. The eggs are the shortest at the age of 48-54 hrs. Egg length at the time immediately before hatching decreases, in comparison to the length of newly laid eggs, to 94.3% in *A. dorsata*, 97.4% in *A. cerana* and 98.9% in *A. florea*. Length changes of the egg and embryo are correlated. The ratio of the length of the embryo to that of the egg varies. At the age of 48 hrs, it ranges from 82% in *A. cerana* and *A. florea* to 97% in *A. dorsata*. Just before hatching, the embryo occupies 91% of the length of the egg in *A. cerana*, 87% in *A. florea*, and 94% in *A. dorsata*. Hence the eggs change their size during the whole period of development. However, neither the direction, nor the ratio of changes are the same for width and length. Nevertheless, eggs before hatching are smaller than the newly laid ones.

The conclusions have practical applications. When queens are selected for the size of eggs, the age of eggs must be determined. Selection can be conducted only on eggs of the same or similar age.

## Abstract

An *Apis cerana indica* queen was confined on a comb under a queen-excluder cap for 4-6 hrs. Eggs were removed at regular intervals and their size was measured. Drawings and measurements of the embryos inside the eggs were made. On this basis, the age of eggs of *A. florea* and *A. dorsata* was determined.

The eggs change their size during the incubation period. The width decreases until hatching time to 87.7% in *A. cerana*, 89.3% in *A. dorsata* and 89.9% in *A. florea*. The eggs are the shortest at the age of 48-54 hs. The length at the time just before hatching decreases to 94.3% in *A. dorsata*, 97.4% in *A. cerana* and 98.9% in *A. florea*. Length changes of eggs are correlated with size changes of the embryos. When queens are selected for the size of eggs, the age of eggs must be taken into account.

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## Key Words

*Apis cerana indica*, *Apis florea*, *Apis dorsata*, embryo size, egg size, development,

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# Asian Apiculture

Edited by  
Lawrence J. Connor,  
Thomas Rinderer,  
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Proceedings of the first International Conference on  
the Asian Honey Bees and Bee Mites

including the  
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by Eva Crane and Penelope Walker

Wicwas Press  
Cheshire, Connecticut 06410 USA  
1993